भारतीय मानक

Indian Standard

IS 3612 : 2023

क्रशिंग एवं ग्राइंडिंग उपकरण — वर्गीकरण और क्षमता मापने की पद्धति

(दूसरा पुनरीक्षण)

Crushing and Grinding Equipment — Classification and Method for Measuring Capacity

(Second Revision)

ICS 91.220

भारतीय मानक ब्यूरो
BUREAU OF INDIAN STANDARDS
मानक भवन, 9 बहादुर शाह ज़फर मार्ग, नई दिल्ली - 110002
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI - 110002
www.bis.gov.in www.standardsbis.in

May 2023 **Price Group 4**

Construction Plant and Machinery Sectional Committee, MED 18

FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Construction Plant and Machinery Sectional Committee had been approved by the Mechanical Engineering Divisional Council.

Size reduction is an important unit operation which finds application in almost all fields of industrial activity. A uniform terminology, classification, and methods for measuring capacity will be helpful to the trade, user, and manufacturer.

This standard was first published in 1966 and subsequently revised in 1994. This standard is being revised again to keep pace with the latest technological developments and international practices. Also, in this revision, the standard has been brought into the latest style and format of Indian Standards, and references of Indian Standards, wherever applicable have been updated.

The composition of the Committee responsible for the formulation of this standard is listed in Annex B.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test shall be rounded off in accordance with IS 2 : 2022 ‘Rules for rounding off numerical values (*second revision*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

CRUSHING AND GRINDING EQUIPMENT — CLASSIFICATIONAND METHOD FOR MEASURING CAPACITY

(Second Revision)

1 SCOPE

This Indian Standard covers the definition of various terms, classification, terminology, sizes, and methods of measuring the capacity of crushing and grinding equipment.

2 REFERENCES

The standards listed below contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to the agreement based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed below:

IS No.	*Title*
IS 460	Test sieves — Specification:
(Part 1) : 2020	Wire cloth test sieves (*fourth revision*)
(Part 2) : 2020	Perforated plate test sieves (*fourth revision*)
(Part 3) : 2020	Methods of examination of apertures of test sieves (*fourth revision*)

3 DEFINITIONS

For the purpose of this standard, the following definitions shall apply:

3.1 Rock — A rock is an aggregate of minerals such as natural rock, ore, and may include other similar materials like coke, slag, etc. Rock structure may be of friable, abrasive, or sandy nature.

3.1.1 The rock may be classified as hard (more than 800 kgf/cm^2), medium hard (300 kgf/cm^2 to 800 kgf/cm^2), and soft (less than 300 kgf/cm^2). The rock may also be classified on the basis of work index and abrasive index.

3.2 Crushability — The force required to break the rock into pieces, by application of a direct, gradually increasing, compressive force (*see* Annex A for method of measurement of crushability).

3.3 Size Reduction Process

3.3.1 *Crushing* — Process of dividing rock by slow compressing it between two hard faces so that it breaks into fragments.

3.3.2 *Breaking* — Process of dividing rock into pieces by application of impact, bending, and shear force.

3.3.2.1 *Impact breakage* — Process of breaking of rock by dynamic impact between the rock and the hammer/impact surface.

3.3.2.2 *Shear breakage* — Process of breaking due to shearing of rock between two surfaces.

3.3.3 *Grinding* — Process of reducing the size of and dividing rock by means of mutual frictional contacts between fragments of rock or between fragments of rock and foreign bodies introduced in the process. This includes size reduction by abrasion, shear, and impact.

3.4 Classification of Machines

3.4.1 *Crusher* — A machine employing crushing (*see* **3.3.1**) for size reduction in which the product size is governed largely by a specific opening between two surfaces and rock characteristics.

3.4.2 *Breaker* — A machine employing breaking (*see* **3.3.2**) for size reduction in which the product size is governed mainly by the force of the blow and rock characteristics.

3.4.3 *Grinder* — A machine employing grinding (*see* **3.3.3**) for size reduction in which the product size is governed mainly by the quantity of material charged per unit time and rock characteristics.

3.4.4 *Ultrafine Grinder* — A machine for reducing finer size rocks to ultrafine sizes (less than 10 microns).

3.5 Stages in Size Reduction — Number of stages in size reduction is determined by maximum size of feed, maximum size of product, receiving ability and allowable reduction ratio for particular machine in each stage.

3.5.1 *Primary* — The crushing deployed to break run-of-mine/excavated rock received directly for first processing.

3.5.2 *Secondary/Tertiary Crushing* — The breaking of rock that has been subjected to primary/secondary breaking in a machine and is to be subjected to further breaking.

3.6 Reduction Ratio — The ratio between the 80 percent passing size of feed and the 80 percent passing size of the crushed product.

4 TERMINOLOGY OF MACHINES

4.1 Crushers

4.1.1 *Jaw Crusher* — A machine for crushing rock mainly by compression between two rectangular surfaces or jaws, one of which (rarely both) alternately approaches and recedes from the other.

4.1.2 *Gyratory Crushers* — A machine for breaking rock or similar material, mainly by compression between a bell shaped crushing head and a bowl of tapering cross-section within which the head moves with a gyratory motion. The head is supported at top spider and these types of crushers are normally deployed for primary crushing.

4.1.3 *Cone Crushers* — A machine for breaking rock or similar material, mainly by compression between a crushing head which has more flared bell with bottom/intermediate support on spherical bearings and a bowl of tapering cross section within which the crushing head moves with an eccentric motion. These type of crushers are mainly deployed for secondary and subsequent stages of crushing.

4.1.4 *Roller Crusher* — A crushing machine consisting of one or more cylinder rollers revolving on their horizontal axes. The peripheral faces of rollers may be smooth, corrugated, or toothed.

4.2 Breaker

4.2.1 *Impact Breaker* — A machine of similar form to the hammer mill except, that the outlet is unrestricted, so that breaking is by free impact only and the hammers may be rigidly attached/hinged to the rotor.

4.2.2 *Hammer Mill* — A machine for breaking rock by free and restricted impact. It comprises a rotor carrying number of discs and hammers revolving inside a box-like chamber lined with or without plates or bars in order to obtain predetermined sizes.

4.3 Grinding Mill

4.3.1 *Ball Mill* — A grinding mill which rotates round a horizontal axis and uses balls of steel or other suitable material to reduce the size of charged materials.

4.3.2 *Rod Mill* — A grinding mill which rotates round a horizontal axis and uses rods of steel or other suitable material to reduce the size of charged materials.

4.3.3 *Tube Mill* — A grinding mill which rotates round a horizontal axis and has the shape of a tube of which the length to diameter ratio is greater than two.

4.3.4 *Autogenous Mill* — A grinding mill which rotates round a horizontal axis and uses suitable sizes of charged material with or without steel balls as grinding media to reduce the size of feed material.

4.4 Ultra Fine Grinding Mills

4.4.1 *Pin Mill* — A grinding mill where a plate with pin rotates, meshed with stationary plate with pins to produce fine particles continuously.

4.4.2 *Attritor* — A mill consisting of a steel vessel filled with steel balls of 5 mm to 10 mm and material. A central shaft with rods attached the particles to sub-micron size.

4.4.3 *Jet Mill* — A high-pressure air jet is used for grinding. Solid particles are introduced into the jet area organized such a way that particles are always thrown towards the jet and fine material is continuously separated after classification.

5 METHOD OF SPECIFYING CAPACITY

5.1 Unless otherwise stated the capacity of a crusher shall be defined as integrated weight in tonnes per hour of the material passing through discharge opening per unit of time based on average operating conditions, when handling dry friable material of medium hardness having a bulk density of 1.6 tonnes/m^3 and soft material having bulk density of 0.8 tonnes/m^3 and assuming that 100 percent of feed is larger than discharge opening of crusher with maximum size in feed 80 percent of crusher feed opening (setting) which can be reduced to product sizes as specified.

5.2 Jaw, Gyratory and Cone Crushers

The capacity shall be expressed in terms of the total product of which 80 percent passes through IS Sieve [*see* IS 460 (Part 1, 2, and 3)] corresponding to operating discharge opening of the crushers.

NOTE — It is recommended that the supplier should provide a table of capacities for a specific feed size and a graph of the sieve analysis of the product at various discharge openings.

5.3 Roller Crushers

The capacity shall be expressed terms of the total product of which 80 percent passes through IS Sieve [*see* IS 460 (Part 1, 2, and 3)] corresponding to operating discharge opening and type of rollers.

NOTE — It is recommended that the supplier should provide a table of capacities for a specific feed size and a graph of the sieve analysis of the product at various discharge openings.

5.4 Grinding Mill, Pulverisers and Ball/Pebbles/Rod Mill

The capacity shall be expressed in tonnes/day for specific feed and product size of which 80 percent passes through IS Sieve [*see* IS 460 (Part 1, 2 and 3)]

NOTE — The manufacturer shall furnish the following information while defining the capacity of mills:

a) Ball loading — Percentage volume of mill occupied by the grinding media;

b) Material loading — Percentage/fraction of volume of voids available between balls occupied by the material

c) Mill loading — Percentage volume of mill occupied by both material and grinding media; and

d) Grinding media size, size distribution, and weight.

ANNEX A
(*Clause* 3.2)

METHOD OF MEASURING CRUSHABILITY OF ROCKS

A-1 GENERAL

A-1.1 Crushability of the rock is the force required to break the rock into pieces by application of a direct gradually increasing compressive force.

A-1.2 Rocks as obtained in nature are always heterogeneous bodies showing weak planes. If the rock chips under pressure, this chipping may be due to any one of several internal zones of weakness which may not necessarily be a stable characteristic of the rock. It is, therefore, necessary to ensure that the breakage is not due to an occasional weak spot. In a completely homogenous body subject to normal compressive stress the breakage should occur in a direction diagonal to the body undergoing the crushing, yielding approximately equal-sized pieces, with some fines. Therefore, when the material breaks into sizes smaller than approximately half of the original size, the indication is that the rock has broken not because of an occasional weak plane, but due to general failure. The breakage should not be taken to represent a complete failure of the rock against the imposed crushing force, if only chipping occurs.

A-1.3 The rock usually has cleavage planes or stratifications, which generally represent weak spots. Rocks, therefore, could show different crushing resistance in different directions. In determining crushing strength, therefore, it is very necessary to determine these variations and take the weakest resistance as the crushing strength of the rock.

A-2 PROCEDURE

A-2.1 A suitable prepared rock specimen is taken and placed on a platform and pressure is applied hydraulically or by any other means capable of gradually increasing the force, with provision made for measuring the compressive force that comes to play on the rock. The gradual application of pressure may be achieved by a hydraulic press with a ram having a surface area of 10 cm^2 and the dial recording the pressure calibrated in terms of kgf/cm^2.

The rock should be prepared so as to present a contact surface both on the platform and to the ram, the area of which should be at least 1.25 times of that of the ram and should fully cover the ram. The pressure is gradually increased until such time that a rupture takes place, nothing down the value of pressure at the time of rupture. The broken pieces are examined for their sizes. If the broken pieces are smaller than half the size of the original piece, the pressure at which the rupture took place, reduced to pressure per unit surface area of contact between the rock and the pressure applying ram, is taken as the crushing strength. If the rock chips on the sides and does not break into pieces less than half the original size, the value may be disregarded and a fresh sample taken for the test. In the case of rocks showing definite directional stratifications or foliations, the pressure may be applied in different directions representing the direction of stratification and a direction at right angles to it. The maximum value obtained is taken as the crushing strength.

ANNEX B

(*Foreword*)

COMMITTEE COMPOSITION

Construction Plant and Machinery Sectional Committee, MED 18

Organization	*Representative(s)*
Directorate General of Quality Assurance, Ministry of Defence, New Delhi	BRIG RAJNEESH BHATNAGAR **(*Chairperson*)**
AIMIL Limited, New Delhi	SHRI ROHITASH BARUA SHRI K. K. VYASAS (*Alternate*)
Airports Authority of India, New Delhi	SHRI G.K. CHOUDHARY SHRI R.L. SHARMA (*Alternate*)
Ajax Engineering Private Limited, Bengaluru	SYED MOHAMMED RIAZ NAWAZ SHRI JORLIN P. V. (*Alternate* I) SHRI MANJUNATH D. JAGGAL (*Alternate* II) SHRI KRISHNA KISHORE (*Alternate* III)
Ammann Apollo India Private Limited, Jagudan, Gujarat	SHRI GIRISH DIXIT SHRI ASHISH PATEL (*Alternate* I) SHRI MANAN RAJPURA (*Alternate* II) SHRI PRASAD DAYAL (*Alternate* III) SHRI GEETESH MAKADIA (*Alternate* IV) SHRI ARPAN PATEL (*Alternate* V) SHRI KARTIK TRIVEDI (*Alternate* VI)
Atlas Copco India Limited, Pune	SHRI VIJAY SHARMA SHRI YOGESH TULJAPURKAR (*Alternate*)
B. G. Shirke Construction Technology Limited, Pune	SHRI A. D. BHOSALE SHRI SUNIL KEDAR (*Alternate*)
Builders Association of India, Mumbai	SHRI V. G. SAKTHIKUMAR
Caterpillar India Private Limited, Chennai	SHRI K. REJI JOSE SHRI RAMESH VISHWANATHAN (*Alternate*)
Central Water Commission, New Delhi	SHRI DILIP KUMAR JHA SHRI KRISHNAJI SINGH (*Alternate*)
CSIR - Central Building Research Institute, Roorkee	DR SUVIR SINGH DR BANTI A. GEDAM (*Alternate*)
Directorate General Border Roads, New Delhi	COL AMIT BHARDWAJ
Directorate General of Quality Assurance, Ministry of Defense, New Delhi	COL RAVI LOGANATHAN LT COL S. TALEWAR (*Alternate*)
Epiroc Mining India Limited, Nashik	SHRI VENKATESAN BASHYAM SHRI MUTTANNA JAPANNAVAR (*Alternate*)
Escorts Construction Equipment Limited, Faridabad	SHRI FAIZ AHMAD SHRI ASHOK CHAUHAN (*Alternate* I*)* SHRI LAXMI CHAND TYAGI (*Alternate* II)
Indian Construction Equipment Manufacturers Association, New Delhi	SHRI K. V. KRISHNAMURTHY
IRCON International Limited, New Delhi	SHRI RANDHIR GUPTA SHRI S. K. RAY (*Alternate*)
Jaypee India Limited, Kolkata	SHRI KUMAR M. MEHTA SHRI RAHUL KUMAR TEOTIA (*Alternate*)

Organization	*Representative(s)*
John Deere India Private Limited, Mumbai	SHRI KARTHIK KALIAPPAN SHRI RAJ ANAND (*Alternate*)
Larsen and Toubro Construction Limited, Karnataka	SHRI GURUPRASAD S. R. SHRI DHANAJI HARIBA MANGUDE (*Alternate*)
Larsen and Toubro Limited, Mumbai	SHRI K. KESHAVA SHRI M. SURESH KUMAR (*Alternate*)
Ministry of Road Transport and Highways, New Delhi	SHRI K. C. SHARMA SHRI JITENDRA KUMAR (*Alternate*)
National Council for Cement and Building Materials, Faridabad	SHRI KAPIL KUKREJA SHRI SAURABH BHATNAGAR (*Alternate*)
Schwing Stetter (India) Private Limited, New Delhi	SHRI RAJEEV SHALIA SHRI VARADHARAJAN R. (*Alternate*)
Volvo Construction Equipments India Private Limited, Bengaluru	SHRI V. R. SAI PRASAD POLIPALLI SHRI K. RAGHURAMAN (*Alternate*)
Wirtgen India Private Limited, Pune	SHRI DEEPAK BHOIR SHRI PARUL ARORA (*Alternate*)
In Personal Capacity (*Flat no. 3052, Prestige Shantiniketan, Whitefield Main Road, Bengaluru*)	SHRI S. N. MAHAJAN
In Personal Capacity (*D-24, Amar Colony, New Delhi*)	SHRI SATENDER KUMAR
BIS Directorate General	SHRI RAJNEESH KHOSLA, SCIENTIST 'F'/SENIOR DIRECTOR AND HEAD (MECHANICAL ENGINEERING) [REPRESENTING DIRECTOR GENERAL (*Ex-officio*)]

Member Secretary
SHRI LOKRAJ MEENA
SCIENTIST 'B'/ASSISTANT DIRECTOR
(MECHANICAL ENGINEERING), BIS

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act*, 2016 to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Copyright

Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the website-www.bis.gov.in or www.standardsbis.in.

This Indian Standard has been developed from Doc No.: MED 18 (20503).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones: 2323 0131, 2323 3375, 2323 9402 *Website*: www.bis.gov.in

Regional Offices:		*Telephones*
Central	: 601/A, Konnectus Tower -1, 6th Floor, DMRC Building, Bhavbhuti Marg, New Delhi 110002	2323 7617
Eastern	: 8th Floor, Plot No 7/7 & 7/8, CP Block, Sector V, Salt Lake, Kolkata, West Bengal 700091	2367 0012 2320 9474
Northern	: Plot No. 4-A, Sector 27-B, Madhya Marg, Chandigarh 160019	265 9930
Southern	: C.I.T. Campus, IV Cross Road, Taramani, Chennai 600113	2254 1442 2254 1216
Western	: Plot No. E-9, Road No.-8, MIDC, Andheri (East), Mumbai 400093	2821 8093

Branches : AHMEDABAD. BENGALURU. BHOPAL. BHUBANESHWAR. CHANDIGARH. CHENNAI. COIMBATORE. DEHRADUN. DELHI. FARIDABAD. GHAZIABAD. GUWAHATI. HIMACHAL PRADESH. HUBLI. HYDERABAD. JAIPUR. JAMMU & KASHMIR. JAMSHEDPUR. KOCHI. KOLKATA. LUCKNOW. MADURAI. MUMBAI. NAGPUR. NOIDA. PANIPAT. PATNA. PUNE. RAIPUR. RAJKOT. SURAT. VISAKHAPATNAM.

Published by BIS, New Delhi